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Soy Beans and Cowpeas

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SOY BEANS AND COWPEAS.

BY T. A. KIESSELBACH.

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A SHOCK OF SOY BEANS.

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U. S. A.

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SOY BEANS AND COWPEAS.

BY T. A. KIESSELBACH.

INTRODUCTION.

In recent years considerable interest has been manifest in Nebraska concerning soy beans and cowpeas; and numerous inquiries regarding them have come to the Experiment Station.

The cowpea is regarded as a profitable crop chiefly in the cotton States, but has some importance as far north as Missouri, Illinois, Indiana, and Ohio. On the other hand, the soy bean is adapted primarily to the Northern States between the regions best suited for cowpeas in the South and Canada field peas in the North. The Central States in which they are most commonly grown are Illinois, Indiana, Ohio, and Michigan, and they have been recommended for Kansas and Missouri. Much has been said of these crops in the States in which they are especially adapted, and the interest in them has spread to Nebraska.

Somewhat extensive experimental tests were made at the Nebraska Agricultural Experiment Station by Dr. T. L. Lyon, now of Cornell University. Included in these tests were nine varieties of soy beans for which yields were determined during the years 1903 and 1904.

In 1909 this Station secured seed of eight representative varieties of soy beans from Mr. C. V. Piper of the United States Department of Agriculture. At that time Professor E. G. Montgomery, now of Cornell University, again took up the testing of soy beans, which has been continued since 1911 by the writer, thus giving a continuous record of six years' work in recent years. Cooperative tests also have been made, during the past three years, with farmers of the State.

Tho our tests with cowpeas have not been extensive, this crop seems much less deserving of trial than soy beans.

HABITS OF GROWTH.

The soy bean is an upright, branching, annual legume varying in height, under normal conditions, from 1½ to 4 feet. It produces a small pod (very similar to the garden pea) which con-

tains from two to four seeds. The stem usually has five or six main branches, upon which are borne the leaves and clusters of seed pods. All the seed matures at practically the same time.

Fig. 1.—A typical soy bean plant.

Fig. 2.—A typical cowpea plant.

On the other hand, the cowpea has pods varying in length, from 5 to 15 inches, according to variety and seasonal conditions. Pods of varieties commonly grown in this State average about 6 inches in length. Under normal conditions the plants continue to bloom and set seed thruout the fall until frost. The most promising varieties suitable for growing in this State have a growth habit somewhat similar to that of the soy bean but are more prostrate and viny. The seeds of each crop differ greatly in size, shape, and color, according to variety. The flowers are usually self-fertilized, and it is not at all necessary for insects to carry the pollen. Figures 1 and 2 are typical soy bean and cowpea plants, respectively.

Being leguminous plants, they possess nodules with nitrogen-gathering bacteria on their roots just as do clover and alfalfa, when the proper bacteria are present in the soil.

Soy beans and cowpeas, in general, require nearly the same length of growing season as corn in eastern Nebraska, altho most varieties are somewhat later in maturing. Of the eight varieties of soy beans, which represent a wide variation in type, tested during the past six years, the earliest ripened September 16 on an average and the latest, October 10.

ADAPTATION AND USES FOR NEBRASKA CONDITIONS.

The uses to which these crops are put in various parts of the world are: (1) Food for man; (2) food for live stock, in the form of grain, hay, pasture, and silage; and (3) as soil restorers. In addition, soy bean oil is being used in the manufacture of paint, and for lubricants. The latter industry promises to develop more extensively.

Experience indicates that at the present time in Nebraska their chief value is as a protein concentrate and as hay for cattle, hogs, and sheep, and possibly for soil improvement. They deserve more extensive trial as food for man.

Indications are that cowpeas never will be a practical crop in this State. The yield of seed is relatively very low, and in forage production cowpeas are not superior to soy beans. The lack of sufficiently early varieties also limits the growing of cowpeas to eastern Nebraska.

Soy beans are the most practicable of any of the annual legumes. They are one of the most drouth resistant crops we have. However, more experience is required to grow a crop of soy beans successfully than is the case with our common field crops.

Varieties of soy beans are available that are sufficiently early to mature anywhere in Nebraska except in the northwestern por-

tion of the State. They may prove of considerable value in central and southwestern Nebraska where drouth resistance is a very important quality.

Several acres of soy beans must usually be planted where jack rabbits and grasshoppers are numerous in order to harvest a crop and make a satisfactory test, because these pests are very fond of soy beans, and frequently destroy smaller areas.

The soy bean has not proved to be a specially profitable crop, but will at least approach oats, acre for acre, in feeding value. Fifteen bushels of seed to the acre, or 1½ tons of cured hay, is an average crop in eastern Nebraska under normal conditions. The yield will be somewhat lower farther west because of more limited rainfall. But on the other hand, the assurance of securing a stand is greater than with leguminous crops having small seeds, such as alfalfa or sweet clover. If the surface soil is too dry for germination, the seed may be planted 2 or 3 inches deep, thus reaching moist soil.

COMPOSITION AND FEEDING VALUE.

In composition and feeding value, the seed of the soy bean ranks very high and is much superior to that of the cowpea. It is a concentrated protein feed, being in this respect practically equal to oil meal. Its fat content is also very high. The soy bean seed contains 3.7 times as much digestible protein and 3.4 times as much digestible fat as corn, pound for pound.

Compared with the commonly used protein concentrate, oil meal, according to percentages given in Table 2, 1 ton, or 33 1-3 bushels, of soy beans contains 582 pounds of digestible protein. This is as much as is contained in 1,927 pounds of old process oil meal. A ton also contains 292 pounds of digestible fat, which is as much as is contained in 4,232 pounds of old process oil meal.

At this Station, during the six years 1909 to 1914, eight varieties of soy beans have averaged a yield of 14 bushels per acre. At this rate of production, the seed from an acre of soy beans contains as much digestible protein as 872 pounds of oil meal, and as much digestible fat as 1,777 pounds of oil meal.

The United States Department of Agriculture has estimated that, when used as a supplementary protein feed for live stock, "a bushel of soy beans is at least twice as valuable for feed as a bushel of corn." (See U. S. Farmers' Bulletin 372, p. 25.) Data are lacking to make an accurate comparative estimate of the feeding value of a carbohydrate concentrate, as corn, and a protein concentrate, as soy beans, under conditions where the protein may be supplied in such remarkably cheap forms as alfalfa,

TABLE 1.—*Relative composition of soy beans and cowpeas as compared with other feeds.*
(Data compiled from Henry's *Feeds and Feeding.*)

Feed	Water	Ash	Protein	Carbohydrates		Fat
				Fiber	Nitrogen free extract	
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Soy beans (grain)	11.7	4.8	33.5	4.5	28.3	17.2
Cowpeas (grain)	14.6	3.2	20.5	3.9	56.3	1.5
Corn (grain	10.6	1.5	10.3	2.2	70.4	5.0
Oats (grain)	10.4	3.2	11.4	10.8	59.4	4.8
Wheat grain	11.9	5.8	15.4	9.0	53.9	4.0
Wheat bran	10.5	1.8	11.9	1.8	71.9	2.1
Oil meal (old process)	9.8	5.5	33.9	7.3	35.7	7.8
Oil meal (new process)	9.0	5.5	37.5	8.9	36.4	2.7
Cottonseed meal (choice)	7.4	6.6	43.1	8.4	26.0	8.5
Peanuts (kernels)	7.5	2.4	27.9	7.0	15.6	39.6
Soy bean hay	11.8	7.0	14.9	24.2	37.8	4.3
Cowpea hay	10.5	8.9	14.2	21.2	42.6	2.6
Clover hay (red)	15.3	6.2	12.3	24.8	38.1	3.3
Alfalfa hay	8.1	8.8	14.6	28 9	37.4	2.1
Timothy hay	13.2	4.4	5.9	29.0	45.0	2.5
Soy bean silage	74.2	2.8	4.1	9.7	6.9	2.2
Cowpea silage	79.3	2.9	2.7	6.0	7.6	1.5
Corn silage	73.6	2.1	2.7	7.8	12.9	0.9

TABLE 2.—*Relative digestible nutrients and fertilizer elements in soy beans and cowpeas as compared with other feeds.*

(Data compiled from Henry's *Feeds and Feeding.*)

Feed	Digestible nutrients				Fertilizing elements		
	Protein	Carbohydrate	Fat	Nutritive ratio	Nitrogen	Phosphoric acid	Potash
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Soy beans (grain)	29.1	23.3	14.6	1: 2.2	5.36	1.04	1.26
Cowpeas (grain)	16.8	54.9	1.1	1: 3.4	3.28	1.01	1.20
Corn (grain)	7.8	66.8	4.3	1: 9.8	1.65	0.71	0.57
Oats (grain)	8.8	49.2	4.3	1: 6.6	1.82	0.78	0.48
Wheat grain	11.9	42.0	2.5	1: 4.0	2.46	2.69	1.52
Wheat bran	8.8	67.5	1.5	1: 8.0	1.90	0.87	0.55
Oil meal (old process)	30.2	32.0	6.9	1: 1.5	5.42	1.66	1.37
Oil meal (new process)	31.5	35.7	2.4	1: 1.2	6.00	1.74	1.34
Cottonseed meal (choice)	35.8	23.2	8.0	1: 1.1	6.90	3.04	1.58
Peanuts (kernels)	25.1	13.7	35.6	1: 3.7	4.46	1.24	1.27
Soy bean hay	10.6	40.9	1.2	1: 4.1	2.38	0.67*	1.08*
Cowpea hay	9.2	39.3	1.3	1: 4.5	1.43	0.52	1.47
Clover hay (red)	7.1	37.8	1.8	1: 5.8	1.97	0.55	1.87
Alfalfa hay	10.5	40.5	0.9	1: 4.0	2.34	0.61	1.79
Timothy hay	2.8	42.4	1.3	1: 1.6	0.94	0.33	1.42
Soy bean silage	2.7	9.6	1.3	1: 4.6	0.66	0.16	0.75
Cowpea silage	1.5	8.6	0.9	1: 7.0	0.43	0.15	0.46
Corn silage	1.4	14.2	0.7	1:11.2	0.43	0.11	0.37

*From Ohio Agr. Exp. Station Bulletin 237.

clover, and sweet clover hay and pasture. In a feeding ration in which alfalfa or clover is fed liberally, there is little to be gained by feeding soy beans in addition. After a sufficient amount of protein has been supplied to balance the ration, any additional amount of protein fed replaces merely part of the carbohydrate. When protein serves merely to replace a carbohydrate, the actual feeding value pound for pound is slightly lower than that of the carbohydrate. Tables 1 and 2 have been compiled from Henry's *Feeds and Feeding*, 1913, to show the composition of soy beans and cowpeas as compared with other feeds. Henry is regarded as a standard authority on the composition of various feeds.

YIELDS IN OTHER STATES.

OHIO EXPERIMENT STATION.

During the three years 1909-1911, 10 varieties of soy beans gave an average yield of 23.62 bushels per acre, while the total weight of the crop harvested, including the entire plant, was 3,528 pounds. During the same period, three varieties of cowpeas produced an average yield of 5.83 bushels of seed, and 2,669 pounds total weight of crop, including the entire plant. The average farm production in Ohio is 18 bushels of soy beans per acre (Ohio Bul. 237). In Ohio Circular 132, 32 cooperative tests during 1912, indicating yields varying from 8 to 50 bushels per acre, are reported.

INDIANA EXPERIMENT STATION.

The average soy bean production at the Indiana Agricultural Experiment Station during the 12 years 1903-1913 was 18.8 bushels of seed per acre, while the yield of hay was 2.3 tons per acre. Cooperative tests by farmers during 1906-1912 in northern Indiana showed an average soy bean yield of 19 bushels of seed per acre. When cut for hay the yield was 1.5 tons. Cowpeas cut for seed yielded 12.5 bushels, and cut for hay the yield was 1.7 tons per acre. Similar cooperative soy bean seed and hay tests in southern Indiana yielded respectively 15.4 bushels of seed and 1.7 tons of hay per acre. (Ind. Bul. 172.)

KANSAS EXPERIMENT STATION.

Soy beans and cowpeas produced on an average during 1903-1908, 13.45 and 11.55 bushels of seed per acre respectively. When cut for hay, the yields were respectively 1.71 tons and 2.19 tons per acre. (Kans. Bul. 120.)

ARKANSAS EXPERIMENT STATION.

During the years 1899-1901 cowpeas yielded 22.9 bushels of seed per acre. When cut for hay, the yield was 1.5 tons. (Ark. Bul. 70.)

KENTUCKY EXPERIMENT STATION.

The average yield of soy beans for three years, 1909-1911, in a rate planting test was 10.6 bushels. It is mentioned that these yields are much lower than should have been expected had more been known concerning the culture of this crop. Frequent reports are received at the Kentucky Agricultural Experiment Station from farmers who produced 20 to 30 bushels of soy beans per acre.

VARIETIES TESTED AT THE NEBRASKA EXPERIMENT STATION.

Nine varieties were tested in unduplicated plats, one-tenth acre in size, during each of two years, 1903 and 1904. The rows were 32 inches apart and cultivated. The results are given in Table 3.

TABLE 3.—*Average yield of nine varieties of soy beans tested at Nebraska Experiment Station, 1903-1904.*

Variety	Date planted	Date ripe	No. days required to mature	Yield of beans per acre (bushels)
Early Yellow	May 30	Sept. 20	112	15.10
American Coffee Berry	May 30	Sept. 20	112	12.72
Early Black	May 30	Sept. 20	112	21.85
Ito San	May 30	Sept. 20	112	12.44
Wisconsin Black	May 30	Sept. 23	115	20.95
Medium Early Yellow	May 30	Sept. 23	115	18.86
Medium Early Brown	May 30	Sept. 23	115	16.62
Medium Early Black	May 30	Sept. 23	115	11.95
Medium Green	May 30	Oct. 4	124	15.04
Average all varieties				16.17

Further testing was discontinued until 1909 when eight varieties of soy beans representing a rather wide range of type were secured from Mr. C. V. Piper of the Bureau of Plant Industry, United States Department of Agriculture. These have been tested for six years, 1909-1914, and the data are given in detail for each year in Tables 4 to 9, in order that variation from year to

year may be observed. They are summarized in Tables 10 and 11. During the first three years, the beans were tested in single cultivated rows 42 inches apart, and duplicated three times, with a few exceptions as indicated in the tables.

During the last three years they have been grown in 4-row plats approximately one-fourteenth and one-seventeenth acre in size, according to space between rows. The entire series has been duplicated four times. They were tested in rows both 28 inches and 35 inches apart—the same amount of seed being sown per row regardless of the distance between rows. This makes the equivalent of two rates of planting—each rate being duplicated.

In the years 1909-1911 they were planted with a 1-row garden drill. In 1912 and 1913 a *Superior Grain Drill* was used with all feeds closed except those which would properly space the rows. In 1914 they were planted with an edge-drop corn planter.

Each year the seeder was so adjusted as to space the seed about 2 inches apart in the row. In rows 35 inches apart, this required approximately 30 pounds per acre with varieties having small seed and 40 pounds with varieties having larger seed.

In the variety and rate planting tests, the seed has been inoculated each year with artificial culture furnished by the United States Department of Agriculture.

The eight varieties from the Government included in these tests are as follows: Habaro, S. P. I. No. 20,405; Shingto, S. P. I. No. 21,079; Chernie, S. P. I. No. 18,227; Haberlandt, S. P. I. No. 17,271; Nuttall, S. P. I. No. 17,253; Cloud, S. P. I. No. 16,790; Amherst, S. P. I. No. 17,275; and Meyer, S. P. I. No. 17,582.

Cowpeas and an additional variety of soy beans, the Early Yellow, were tested in 1913 and 1914.

TABLE 4.—*Variety test of soy beans. 1909.*

Variety	Date planted	Date ripe	No. days required to mature	No. of duplications	Yield of beans per acre (bushels)
Habaro	June 3	Sept. 16	106	2	8.65
Shingto	June 3	Sept. 24	114	5	9.37
Chernie	June 3	Sept. 29	119	2	8.37
Haberlandt	June 3	Sept. 28	118	4	11.57
Nuttall	June 3	Sept. 29	119	4	7.12
Cloud	June 3	Oct. 5	125	4	12.40
Amherst	June 3	Oct. 14	134	4	14.40
Meyer	June 3	Oct. 14	134	4	10.32

1. 2. 3. 4. 5.

6. 7. 8. 9. 10. 11.

Fig. 3.—The varieties tested during 1909-1914. All but the Early Yellow soy bean and the cowpeas were tested six years. Reading from left to right, upper row: Cowpeas—1, New Era; 2, Whippoorwill. Soy Beans—3, Meyer; 4, Amherst; 5, Cloud. Lower row: 6, Nuttall; 7, Haberlandt; 8, Chernie; 9, Shingto; 10, Habaro; 11, Early Yellow.

TABLE 5.—*Variety test of soy beans. 1910.*

Variety	Date planted	Date ripe	No. days required to mature	No. of duplications	Yield of beans per acre (bushels)
Habaro	May 25	Sept. 17	115	3	20.3
Shingto	May 25	Sept. 23	121	3	20.0
Chernie	May 25	Sept. 24	122	3	20.1
Haberlandt	May 25	Sept. 29	127	3	19.7
Nuttall	May 25	Sept. 30	128	3	24.3
Cloud	May 25	Oct. 5	133	3	22.3
Amherst	May 25	Oct. 5	133	3	29.9
Meyer	May 25	Oct. 8	136	3	26.1

TABLE 6.—*Variety test of soy beans. 1911.*

Variety	Date planted	Date ripe	No. days required to mature	No. of duplications	Yield of beans per acre (bushels)
Habaro	May 25	Sept. 20	118	3	15.26
Shingto	May 25	Sept. 30	128	3	15.81
Chernie	May 25	Sept. 30	128	3	14.88
Haberlandt	May 25	Sept. 28	126	3	22.71
Nuttall	May 25	Sept. 30	128	3	22.14
Cloud	May 25	Oct. 6	134	3	18.79
Amherst	May 25	Oct. 7	135	3	21 96
Meyer	May 25	Oct. 7	135	3	21.03

TABLE 7.—*Variety test of soy beans. 1912.*

Variety	Date planted	Date ripe	No. days required to mature	No. of duplications	Yield of beans per acre. Average of 2 rates (bushels)
Habaro	May 21	Sept. 16	118	4	12.90
Shingto	May 21	Sept. 16	118	4	12.95
Chernie	May 21	Sept. 16	118	4	12.85
Haberlandt	May 21	Oct. 5	137	4	11.95
Nuttall	May 21	Oct. 5	137	4	9.39
Cloud	May 21	Oct. 5	137	4	8.69
Amherst	May 21	Oct. 5	137	4	8.93
Meyer	May 21	Oct. 5	137	4	9.70

TABLE 8.—*Variety test of soy beans. 1913.*

Variety	Date planted	Date ripe	No. days required to mature	No. of duplications	Yield of beans per acre. Average of 2 rates (bushels)
Habaro	June 2	Sept. 11	101	4	7.82
Shingto	June 2	Sept. 20	110	4	8.12
Chernie	June 2	Sept. 13	103	4	9.38
Haberlandt	June 2	Sept. 25	115	4	5.95
Nuttall	June 2	Sept. 29	119	4	6.04
Cloud	June 2	Oct. 11	131	4	3.85
Amherst	June 2	Oct. 11	131	4	2.63
Meyer	June 2	Oct. 11	131	4	5.09
Early Yellow	June 2	Sept. 7	96	4	6.60
Cowpeas.					
New Era	June 2	Sept. 14	104	4	2.00
Whippoorwill*	June 2	.....	.....	4	0

*The Whippoorwill variety set practically no seed pods.

TABLE 9.—*Variety test of soy beans. 1914.*

Variety	Date planted	Date ripe	No. days required to mature	No. of duplications	Yield of beans per acre. Average of 2 rates (bushels)
Habaro	May 20	Sept. 15	118	4	16.78
Shingto	May 20	Sept 28	131	4	15.78
Chernie	May 20	Sept. 28	131	4	16.54
Haberlandt	May 20	Oct. 5	138	4	21.49
Nuttall	May 20	Oct. 5	138	4	16.29
Cloud	May 20	Oct. 10	143	4	14.29
Amherst	May 20	Oct. 10	143	4	17.39
Meyer	May 20	Oct. 17	150	4	16.24
Early Yellow	May 20	Sept. 12	115	4	15.70
Cowpeas.					
New Era	May 20	Sept. 15	118	4	4.6
Whippoorwill*	May 20	.....	.....	4	0

*The Whippoorwill cowpeas produced no seed pods.

TABLE 10.—*Showing six years' average performance of eight soy bean varieties. 1909-1914.*

Variety	Average date planted	Average date ripe	Average no. days required to mature	Total no. plats averaged	Yield of beans per acre (bushels)
Habaro	May 25	Sept. 16	114	20	13.62
Shingto	May 25	Sept. 23	121	23	13.67
Chernie	May 25	Sept. 23	121	20	13.69
Haberlandt	May 25	Sept. 30	128	22	15.56
Nuttall	May 25	Oct. 1	129	22	14.21
Cloud	May 25	Oct. 7	135	22	13.39
Amherst	May 25	Oct. 9	137	22	15.87
Meyer	May 25	Oct. 10	138	22	14.75

TABLE 11.—*Summary of variety tests with soy beans for six years. 1909-1914.*

Variety	Air-dry yield per acre—bushels.						
	1909	1910	1911	1912	1913	1914	6-year average
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
Habaro	8.65	20.30	15.26	12.90	7.82	16.78	13.62
Shingto	9.37	20.00	15.81	12.95	8.12	15.78	13.67
Chernie	8.37	20.10	14.88	12.85	9.38	16.54	13.69
Haberlandt	11.57	19.70	22.71	11.95	5.95	21.49	15.56
Nuttall	7.12	24.30	22.14	9.39	6.04	16.29	14.21
Cloud	12.40	22.30	18.79	8.69	3.85	14.29	13.39
Amherst	14.40	29.90	21.96	8.93	2.62	17.39	15.87
Meyer	10.32	26.10	21.03	9.70	5.09	16.24	14.75
Average	10.28	22.84	19.07	10.92	6.11	16.85	14.35

SOY BEANS AND COWPEAS FOR HAY.

In 1912 and 1913 both soy beans and cowpeas were drilled in rows 8 inches apart, for hay and seed. Under these conditions the crop could not be cultivated and was overcome by weeds each year. This has not proved a practical way for planting in eastern Nebraska, altho it might prove satisfactory in the western part of the State where weeds are not so troublesome because of lower rainfall. Several duplicate plats were planted in 1912 and 1914 in rows 28 inches apart which were cultivated and harvested for hay, the results from which are given in Table 12. Judging from the general appearance of the plant, the Cloud variety would make a better quality of hay than the other varieties tested.

TABLE 12.—*Summary of hay yields in 1912 and 1914.*

Year	Crop	Yield of cured hay per acre	Yield of cured hay per acre
		Pounds	*Tons*
1912	Whippoorwill cowpeas	2,729	1.37
	Amherst soy beans	2,856	1.43
1914	Whippoorwill cowpeas	2,900	1.45

The hay from either of these crops when properly cured makes excellent forage for cattle, hogs, and sheep. Its feeding value is practically equal to alfalfa and clover. Being less productive, however, and more difficult to grow where cultivation is necessary to keep down weeds, they are not so profitable as either alfalfa or clover in those parts of the State where the latter two thrive.

Three tons of alfalfa hay per acre were produced at the Nebraska Agricultural Experiment Station in those years when soy beans and cowpeas yielded not quite 1½ tons of hay. In this comparison the alfalfa field was several years old, and the soy beans and cowpeas were planted in cultivated rows 28 inches apart.

Because of their forage value these crops need seldom be considered a total failure. Their hay value is very important when too late a variety is planted to mature satisfactorily, or if for any other reason the seed yield promises to be very small, as the field may then be harvested for hay.

SOY BEANS AND COWPEAS FOR SILAGE.

In some States both soy beans and cowpeas are recommended for silage as a mixture with corn. Used alone they are not suitable for silage. They may be planted: (1) As a mixture in the same row with corn; (2) in rows between widely spaced corn rows as is common in the South; or (3) the beans or peas and the corn may be grown in separate fields and mixed as they are placed in the silo.

At the Nebraska Agricultural Experiment Station, corn yields on an average about 8 tons of silage per acre. Those varieties of soy beans and cowpeas making the maximum amount of vegetative growth yield at the rate of about 6 tons of silage, or three-fourths as much as corn. As a general farm practice we consider it far more practicable in this State to make silage of corn alone and to grow alfalfa hay for the protein needed to balance the ration.

In 1914 soy beans of the Cloud variety were planted in the rows of corn for mixed silage. The results follow:

TABLE 13.—*Yields of soy beans and corn planted together for silage. 1914.*

Crop	Yield per acre of green silage	Per cent water when harvested September 5	Yield per acre moisture free substance
	Tons	*Per cent*	*Tons*
Corn alone	9.98	75.4	2.45
Corn and soy beans mixed	9.84	74.7	2.49

We were unsuccessful in securing a satisfactory distribution by mixing the corn and beans in the planter box. The beans tend to work to the bottom and feed out faster than the corn. In the above trial, the corn was drilled 14 inches apart in the row, and the rows were then gone over again with the planter, drilling the beans about 6 inches apart.

Some farmers have reported growing cowpeas and corn together in the row for silage and found difficulty in harvesting the beans properly with the corn harvester. This method of culture is not recommended.

RELATIVE YIELDS OF SOY BEANS AND PRINCIPAL GRAIN CROPS AT NEBRASKA EXPERIMENT STATION.

Moisture conditions at the Experiment Station have been comparatively unfavorable for corn and soy beans during the past six years in which these comparisons are made. This is shown by the fact that corn has produced 25 bushels per acre less at the Station during the past six years than during the previous seven years. Since soy beans occupy the same part of the growing season as corn, the yield from them may be assumed to have been reduced in somewhat the same manner. Wheat and oats have yielded practically the same during the last six years as during the preceding seven.

In Table 14 the grain yields are reported from our standard, best adapted varieties. Since the Haberlandt variety of soy beans seems best adapted to conditions at the Experiment Station, the yield of this variety makes a better comparison with the other grains than does the average yield from the eight varieties. In Table 15 these crop yields are calculated in terms of available nutrients.

TABLE 14.—*Summary showing comparative yields of corn, wheat, oats, and soy beans at Nebraska Experiment Station for the last six years. 1909-1914.*

Crop	Yield per acre						Average for 6 years	
	1909	1910	1911	1912	1913	1914		
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Lbs.*
Hogue's Yellow Dent corn	41	58	43	48	8	53	42	2,352
Turkey Red wheat	27	48	51	9	50	34	36.5	2,160
Kherson oats	67	42	38	37	45	68	49.5	1,568
Average of 8 soy bean varieties	9	23	19	11	6	17	14	840
Haberlandt soy beans	11.5	20	23	12	6	21.5	16	960

SOY BEANS AND COWPEAS AS SOIL IMPROVERS.

For the purpose of increasing the soil fertility, either of these crops is much inferior to clover or alfalfa. On very poor soil it may pay to plow under an entire crop. In this way an amount of nitrogen will be added to the soil equivalent to that of an equal quantity of clover. According to Dr. Cyril G. Hopkins of the Illinois Agricultural Experiment Station (in *Soil Fertility and Permanent Agriculture*) the stubble and roots of a ton of air-dry soy bean forage contain only about 6 pounds of nitrogen while the stubble and roots of a ton of air-dry clover hay contain 20 pounds of nitrogen. Accordingly an average yield of red clover cut for hay in eastern Nebraska will leave four times as much nitrogen in its roots and stubble as an acre of soy beans cut for seed. Clover has probably about the same superiority over cowpeas.

It has sometimes been suggested that these crops be used as green manure crops to be planted in the stubble after the wheat or oats harvest and plowed under late in the fall. It has been our experience that, in Nebraska, success with this practice is very uncertain because of limited rainfall. Only a small total growth is made so late in the year, and the increased fertility would usually scarcely repay the cost of seed and labor. Furthermore, to grow such a catch crop for green manuring uses soil moisture at the expense of the following year's crop, as much of this moisture might otherwise be stored in the soil for the next crop. In Nebraska where moisture is often the limiting factor in crop production, the situation is different from that in the more humid States to the east and southeast, where catch crops are profitably used in this manner.

TABLE 15.—*Showing average yield of digestible nutrients of corn, wheat, oats, and soy beans at Nebraska Experiment Station during the six years—1909-1914.*

Crop	Yield grain per acre, average 6 years	Digestible nutrients				
		Protein	Carbohydrates	Fat	Starch equivalent of fat*	Total starch equivalent of starch and fat†
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Hogue's Yellow Dent corn	2,352	183.4	1,571.1	101.1	227.5	1,798.6
Turkey Red wheat	2,190	192.7	1,478.2	32.8	73.8	1,552.0
Kherson oats	1,584	139.3	779.3	68.1	153.2	932.5
Haberlandt soy beans	960	279.3	223.6	140.1	315.2	538.8
Average of 8 soy bean varieties	840	244.4	195.7	122.6	275.8	471.5

*This column is obtained by multiplying the amount of fat by 2.25. One pound of fat is equal in feeding value to 2.25 pounds of starch.

†This column is obtained by adding to the actual amount of starch the amount of starch which is equal to the fat in feeding value.

PLACE IN THE ROTATION.

In portions of the State where the earlier varieties mature in time, soy beans and cowpeas may sometimes be followed to good advantage with winter wheat. These crops leave the ground in such a loose and open condition that a satisfactory seed bed for wheat can often be secured by simply disking rather than by plowing the land. It is probable, however, that in ordinary farm practice it may not always be possible to clear the land in time for wheat, as abnormal conditions may cause the crop to ripen late or rains may delay removing it from the land. Any spring planted farm crop may successfully follow these legumes. Under Nebraska conditions either soy beans or cowpeas should be grown only with the expectation that they will consume the entire season. It will, therefore, be necessary to grow them in place of, rather than in addition to, some other crop in any one season.

VARIETIES AND SEED.

For southeastern Nebraska we consider the Haberlandt variety best. For the northern, central, and western portions of the State, the Habaro, Chernie, Shingto, and Early Yellow are most suitable. It is probable that of these early varieties Early Yellow (Ito San) is the only one commercially available. Seed houses may not handle the Haberlandt variety, in which case the Medium Yellow may be used as a substitute. This is a medium early commercial variety but a trifle late for all except the southeastern counties in this State. There would doubtless be an opportunity for a few farmers in the State to grow seed of well-adapted varieties to supply the home trade. Seed usually sells for from $2.50 to $3.50 per bushel.

Of the cowpea varieties, the New Era seems to be one of the most practical to grow in this State.

Seed of both soy beans and cowpeas usually deteriorates in germinative power when more than one or two years old.

INOCULATION.

Soy beans and cowpeas, being leguminous plants, are more productive when nodules develop upon the roots and are less draining upon the nitrogen content of the soil. These nodules are merely the home of innumerable nitrogen-gathering bacteria or germs, which take this element directly from the air. These nodule-forming bacteria are found on no field crop plants except those belonging to the legume family. The soy bean possesses its own particular kind of bacteria and cannot be inoculated with

germs from any other species. On the other hand, soy bean bacteria will inoculate no other plant. The cowpea likewise possesses its own peculiar bacteria.

In soils where nodules fail to develop, inoculation may be secured by scattering 300 or 400 pounds of soil per acre from some field upon which the same crop has previously been grown. Since strong sunlight is injurious to the bacteria, this soil should be scattered on a cool, cloudy day and be harrowed in immediately.

A common, but more uncertain, method of inoculation is to apply to the seed a prepared culture made for the particular crop. Inoculating cultures may usually be secured free of charge from the United States Department of Agriculture, Washington, D. C., upon request, by agreeing to leave a portion of the field untreated and reporting results. Cultures may also be purchased from manufacturers and seed dealers. Methods for inoculating these crops are the same as have often been described for alfalfa.

Unless the soil is known by experience to contain the necessary bacteria, it is a wise plan to inoculate before seeding. A number of farmers in the State have reported beneficial effects from inoculating the seed, altho the majority have observed no benefit. The soils at the Nebraska Agricultural Experiment Station appear to possess the soy bean bacteria, as inoculation by both the culture and the soil method failed to increase the yield materially, as is shown in the following table:

TABLE 16.—*Effect of inoculating soy beans.*

Year	Crop	Size of plat	No. of duplications	Yield per acre		
				Soil inoculated	Culture inoculated	No inoculation
		Acre		*Bus.*	*Bus.*	*Bus.*
1912	Amherst soy beans	1-6	2	15.7	16.4	15.9
1913	Amherst soy beans	1-10	2	3.8	4.5	3.1
Average for 2 years				9.8	10.4	9.5

TIME, RATE, AND MANNER OF PLANTING.

Soy beans and cowpeas should be planted immediately after corn planting time. Varying somewhat in different years according to seasonal conditions, May 15 to May 30 may be considered as the best range of planting dates for Nebraska. Earlier planting will usually not hasten maturity, and may result in a poor stand. It is important that the ground be thoroly warm at planting time.

The seed bed should be prepared the same as for corn. Our experience at the Experiment Station has been only with plowing and surface planting. This is the method also commonly employed in other States. There are a few advocates of listing. In western Nebraska listing is probably a good practice, but the method has not been sufficiently tried for general recommendation.

During the last three years of the variety test at this Station, 1912-1914, each variety was planted in plats with rows 28 and 35 inches apart. With both spacings, the seeds were dropped ap-

Fig. 4.—A typical field of soy beans planted in rows 35 inches apart and cultivated.

proximately 2 inches apart in the row. This required about 40 pounds of seed per acre with the large seeded varieties and 30 pounds with the small seeded varieties in rows 35 inches apart. During the three years, the average yield of the four earliest varieties, with September 23 as an average ripening date, was 1 bushel more per acre when the rows were 28 inches apart; while the four latest maturing varieties, ripening on an average October 7, yielded 1 bushel less when the rows were 28 inches apart. The later varieties made the largest vegetative growth and fully occupied the ground at the thinner rate of planting, while this was

not true of the smaller, earlier varieties. The results of this test are given in Table 17.

TABLE 17.—*Showing the effect of distance between rows and rate of planting soy beans.*

Variety	1912		1913		1914		Average	
	Distance between rows							
	35 in.	28 in.	35 in.	28 in.	35 in.	28 in.	35 in.	28 in.
	Bus.	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*	*Bus.*
Habaro	12.30	13.50	7.25	8.39	15.72	17.85	11.76	13.25
Shingto	13.50	12.40	7.58	8.66	14.42	17.12	11.83	12.73
Chernie	14.25	11.25	7.67	10.23	14.25	18.84	12.06	13.44
Haberlandt	11.45	12.45	5.54	6.37	21.82	21.15	12.94	13.32
Nuttall	10.15	8.60	5.98	6.11	18.42	14.17	11.52	9.63
Cloud	7.90	9.45	3.30	4.00	15.83	12.75	9.01	8.73
Amherst	10.05	7.80	2.81	2.43	17.18	17.61	10.01	9.28
Meyer	11.00	8.40	5.70	4.48	16.15	16.32	10.95	9 73
Average all varieties	11.33	10.48	5.73	6.33	16.72	16.98	11.26	11.26

Experience at other Agricultural Experiment Stations leads us to believe that cowpeas should be planted somewhat thinner than soy beans in rows 35 inches apart.

An ordinary grain drill, with part of the feeds closed to give proper width between the rows, is the best machine for planting. Of the different types of force feed in drills, one kind has a disk such that in forcing out the seed for various rates of planting it revolves at different speeds. This type does not crack the seed much and does good work. The oats side of the drill should be used and set between 9 and 12 pecks per acre, according to size of seed. The drill may be easily adjusted if this does not give the proper spacing. A corn planter fitted with bean plates may also be used quite successfully. Plates regularly accompanying corn planters can usually be adjusted or altered so as to space the seed properly. The machine to be used should be tested and adjusted in advance so as to space the seed between 2 and 3 inches apart. The rows should not be closer than 28 inches because of increasing the difficulty of cultivation.

Where seed is drilled from every drill spout in rows 7 inches apart for forage or green manuring, 6 pecks per acre should be used. It must be remembered that weeds are likely to become bad in uncultivated fields.

CULTIVATION.

It is recommended that the field be disked and harrowed just prior to seeding in order to check the weed growth as much as possible. A weeder may be run over the ground just before the beans come up and again before the beans are large enough to cultivate. The weeder should be used only during the warmer portion of the day, as the plants are inclined to be brittle and break in the morning. Three or four cultivations are required. It has been our experience that ordinarily at least one hoeing along the

Fig. 5.—Cowpeas ready to harvest.

row when the plants are small will be necessary. One man can hoe about an acre a day.

The labor connected with growing the crop makes it a rather poor substitute for oats so far as the management of farm labor is concerned. If soy beans were grown extensively, the acreage of corn would necessarily be reduced, since both require cultivation at the same time.

HARVESTING.

Soy beans and cowpeas may be harvested with a mower or a specially made bean harvester. We have also found it practicable to harvest soy beans for seed with a binder. Some varieties are

too short and others too viny to harvest in this manner. In case a mower is used, it is well to have a side delivery attachment in order that the horses will not need to tramp on the cut swath of beans. This tramping is likely to shatter many of the beans.

In general, the proper stage to cut soy beans for seed is when the pods have turned brown or blackish according to variety, and about two-thirds of the leaves have fallen. During this stage of development, they require close attention, because if cutting is delayed, considerable loss of seed will be sustained from shatter-

Fig. 6.—Soy beans ready to harvest for seed.

ing. This is especially true in case of frost. If the beans are permitted to stand until thoroly ripe, much loss of seed may be expected from this source. Inexperienced growers are likely to suffer serious loss from shattering of the seed thru improper handling.

After curing in the windrow for a day or two, the beans should be placed in shocks. When thoroly cured it is best to thresh them immediately. In case this cannot be done, they should be stacked to avoid unnecessary exposure and consequent shattering in the shock. Soy beans, when stacked, should be covered with canvas or coarse hay to exclude rain.

Cowpeas differ greatly from soy beans in their manner of ripening seed. Under normal conditions they continue to bloom and set pods thruout the fall until frost. As a grain crop, they should be harvested when, in the judgment of the grower, the maximum amount of seed is ripe.

For hay the crop should be harvested when the pods are well formed. At this stage most of the leaves are still on, and the stems have not become coarse and woody. After curing in the swath a day or two, they may be raked and cocked. Cowpeas dry more slowly than soy beans. It may take a week or 10 days of good drying weather before either crop can be stacked. This is a serious handicap.

THRESHING AND STORING.

These crops may be threshed with an ordinary threshing machine by reducing the speed of the cylinder and replacing all or part of the concaves by blank concaves. The best adjustment of the thresher is by the use of special pulleys which reduce the speed of the cylinder without reducing that of the rest of the working parts of the machine. Many of the seeds are likely to be broken in threshing, but this does not reduce their feeding value.

The beans or peas should be watched carefully after threshing to avoid heating and molding. When thoroly dry, there is no such danger. Unless very dry it may be necessary to spread them out rather thin for a time.

FARMERS' TESTS WITH SOY BEANS.

During the years 1912, 1913, and 1914 the Experiment Station supplied a number of farmers with soy bean seed, together with suggestions relative to planting, cultivating, and harvesting the crop. In all cases the soy beans were planted in rows and cultivated. The farmers either were supplied with both inoculated and uninoculated seed for comparison, or were furnished inoculating culture from the United States Department of Agriculture.

TESTS IN 1912.

In 1912 three farmers in southeastern Nebraska tested Amherst soy beans for seed with rather encouraging results. Their yields were respectively 18, 20, and 20 bushels per acre. From two to three acres were grown by each man.

TESTS IN 1913.

Ten reports were received from farmers growing soy beans in 1913. The area planted varied from ½ to 6 acres. Only three

men harvested their crop for seed, with yields of 6, 8, and 15 bushels, respectively. Owing to the extreme drouth, and in some instances to inexperience either in planting or harvesting, the others did not thresh their crop. The beans were pastured in two cases with satisfactory results. Two cooperators cut their crop for hay, which yielded at the rate of 1½ tons per acre, and reported that the stock to which it was fed—milch cows and sheep—liked it fully as well as choice alfalfa hay. It should be noted that in these cases the crops were not promising for seed on account either of drouth or danger from frost.

Six of these farmers found it necessary to hoe the soy beans at least once. Cultivation proved more difficult and weeds harder to subdue than in the case of corn planted with a planter. There was no noticeable superiority in development due to the use of inoculation culture in eight of these ten tests.

Four of these farmers intended planting soy beans again the following year, and only one reported having seed for sale. Opinion as to the utility of this crop was quite evenly divided, but in a comparative way the soy bean was ranked as inferior to our standard crops in nearly all cases.

TESTS IN 1914.

Nineteen farmers reported results of their trials with soy beans. The areas planted were in most cases from 1 to 3 acres in extent, and the yield was from 3 to 30 bushels per acre. The data may be summarized as in the following table:

TABLE 18.—*Farmers' tests with soy beans. 1914.**

Question	No. of replies yes	No. of replies no	Doubtful
Were they harder to cultivate than corn?	10	1	1
Was it harder to keep weeds down?	10	1	
Do they need hoeing?	9	1	1
Are they a practical crop?	1	6	3
Will you grow them again?	4	6	1
Did inoculation prove favorable?	2	6	1
Does this crop mature?	3	1	3
Have you seed to sell?	1	8	
Does yield compare favorably with other crops?	2	6	2
Do they ripen in time to follow with winter wheat?	2	2	2

* The average yield of seven farmers reporting the yield was 14 bushels per acre.

The relatively small number of replies to the questions as shown in the table is due either to the fact that many of the cooperators replied only to a part of the questions asked, or their crops were discarded owing to poor stands or damage.

Besides finding this crop harder to handle than most of our field crops, and less profitable, mention was made of damage resulting from jack rabbits, drouth, hail, wind, rain, frost, and shattering.

In considering the reports for 1913 it must be borne in mind that that season was an unusually dry one in southeastern Nebraska, where most of these trials were made, and that for this reason less trouble was caused by the growth of weeds than would be the case in years of average rainfall.

Taken as a whole, these reports from our cooperators are unfavorable to soy beans as a general purpose crop in Nebraska, but we should not underestimate the fact that inexperience in growing this crop is an important adverse factor.

SUMMARY.

1. The climatic adaptation of soy beans to Nebraska conditions as a whole is much better than that of cowpeas. Varieties may be had which will mature before frost in all parts of the State, except perhaps in the northwest. On the other hand, cowpeas should, at least for the present, be confined to the southern and southeastern portions of this State.

2. Soy beans do not show the effects of drouth as quickly as corn, and reductions in yield due to drouth are relatively less marked. However, soy beans are by no means entirely drouth resistant, and the amount and distribution of rainfall are important controlling factors.

3. Neither soy beans nor cowpeas are grown extensively in Nebraska. They have been tried in an experimental way for 15 years, but have nowhere come into common use.

4. In those States where these crops have come into favor with farmers, they are used for grain, hay, silage, pasture, and soil improvement. In Nebraska their chief value is, doubtless, as a grain crop to provide a protein concentrate for live stock. The low grain yields of cowpeas make them impractical, therefore, in this State. Soy beans merit more extensive trial as human food.

5. Under Nebraska conditions, alfalfa and red clover yield more forage with lower labor cost and are much more effective in soil improvement than are cowpeas or soy beans. It must be remembered, however, that, excepting in valleys and otherwise

favored locations, red clover is satisfactory only in the eastern third, and alfalfa only in the eastern two-thirds, of the State.

6. Ordinarily, cowpeas and soy beans should be planted in rows from 30 to 35 inches apart with the seed spaced from 2 to 3 inches in the row. Planted in this manner, at least three cultivations and usually one hoeing are necessary to keep down the weeds.

7. The average yield of soy beans during eight years at the Nebraska Agricultural Experiment Station has been 14.8 bushels per acre. In feeding value per acre this is less than was obtained from oats, and the cost of production was higher.

8. Since soy bean grain must be used for feed in the same manner as oil meal and is equal in value as a concentrate, the cost of the oil meal may be used as a standard to measure the acre value of soy beans. It must be remembered, however, that the protein needed to accompany corn and balance the ration can usually be much more cheaply supplied in the form of alfalfa hay and alfalfa pasture, the latter being especially good for hogs.

9. Since soy beans require cultivation in a manner similar to corn and at about the same time, they should be compared with corn in point of practical utility. The soy bean is one of those crops which look promising and inviting but which nevertheless are not quite sufficiently meritorious to take a place among our standard crops under existing conditions.

(3-6-'15- 15M.)